

Back-of-the-Envelope Physics**Winter Term 2023/24****Sheet 6**

1. A particle of mass m is in a bound state of the potential well $V(r)$ with $V(r) = \infty$ for $r < 0$, $V(r) = 0$ for $0 < r < a$ and $V(r) = W$ for $r > a$. W is a positive constant.

a) Sketch the potential together with the shape of the ground-state wave function.

b) Using a), derive the lower limit for the energy of the ground state.

c) Using b), determine the minimum value that W must have in order for a bound state to exist.

2. Discuss the exact solution for the bound states of problem 1.

3. Estimate the energy needed to remove one electron from the ground state of a helium atom (first ionization energy).

4. Use the Weisskopf model to estimate the binding energy of a negatively charged hydrogen atom H^- . Compare with the experimental result and discuss what you find.